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# PRODUCTION MACHINE WITH ELECTRICAL DRIVES FOR USE IN THE PLASTICS INDUSTRY [PRODUKTIONSMASCHINE MIT ELEKTRISCHEN ANTRIEBEN FÜR DEN EINSATZ IN DER KUNSTSTOFFINDUSTRIE]

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DESCRIPTION /1*

The invention relates to a production machine for use in the plastics industry, like plastic injection molding machine, extrusion machine or blow molding machine, having:

- movable molding elements for molding a plastic part
- at least one material supply element to the cavity of the molding element
- an electrical drive for movement of the molding elements
- an electrical drive for the material supply element
- an electrical drive for moving the material supply element.

A production machine corresponding to the one above is known from WO 91/00418.

The object of the invention is to improve a corresponding production machine in technology and cost-effectiveness.

The object is achieved in that at least one of the electrical drives is designed as an electrical direct drive. Because of this solution according to the invention, a situation is advantageously achieved in which the drives can be connected to the machine mechanical elements without coupling elements. The installation is space-saving and thus more economical. In addition, the machine dynamics are improved.

In one design of the invention, it is provided that the electrical direct drives are designed as built-in motor units. This means an especially space-saving drive construction is possible.

In another design of the invention, it is provided that the built-in

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* Numbers in the margin indicate pagination in the foreign text.

motor units are designed as permanent-field units. Thus an especially advantageous design of the built-in motor units is achieved and the power density of the drive is increased.

In another design of the invention, it is provided that the built-in motor units are designed as synchronous motor units. This advantageously results in the possibility of use of known machine tool regulators and controls.

In another design of the invention, it is provided that the built-in motor units are liquid-cooled. The result is an especially advantageous design of the cooling. The power density that can be achieved is high.

In another design of the invention, it is provided that the built-in motor units are designed so they operate without transmission means like belts, gears, hydraulic elements or rack. This results in a compact construction due to the elimination of transmission elements.

In another design of the invention, it is provided that the built-in motor units are designed with minimized weight. This advantageously results in high dynamics of the built-in motor units.

In another embodiment of the invention, it is provided that instead of synchronous motor units, asynchronous motor units are provided. In this way, advantageous use of especially cost-effective drive units is possible.

In another design of the invention, it is provided that the built-in motor units have other components like position sensors, coupling flanges or chucks. This produces a complete drive that is advantageously simple to connect.

In another design of the invention, it is provided that the built-in motor units are designed so they are air-cooled. Thus especially simple cooling results.

In another design of the invention, it is provided that the built-in motor units are designed as linear motors. Thus an especially simple linear drive unit for movable parts advantageously results.

In another design of the invention, it is provided that the direct drives according to the invention have a digital control. This means that the usual machine tool controls and regulators can advantageously be used.

In another design of the invention, it is provided that the direct drives according to the invention have digital control units with analog or digital interface for the control input. Advantageously the use of the usual sensors with analog outputs in possible.

Finally, in another design of the invention, it is suggested that the direct drives according to the invention have digital interfaces. This means that advantageously an incorporation into the usual control and regulating systems is possible.

The invention will be explained in more detail using drawings, from which further inventive details can also be seen from the description. In detail, in the drawings:

Fig. 1 shows a built-in motor unit according to the invention in the design with a permanent field synchronous motor in 3D representation,

Fig. 2 shows a cross section through a built-in motor unit according to the invention and

Fig. 3 shows the control system according to the invention.

In Fig. 1, 1 designates the motor part of the built-in unit. A mounting flange is indicated with 2 and the hollow shaft with 3. A compact construction results because of the elimination of belts, gears, hydraulic components and couplings. High power density due to liquid cooling. High precision on the workpiece because of a rigid drive train. An additional position sensor eliminated. Simple spindle construction with 90% less loss power in the rotor, i.e. significantly lower bearing heating. Higher efficiency and lower cooling power.

In addition, a more compact machine construction results with a higher torque (approx. 60%) with the same active part volume. The consequence is better work results.

The thermal utilization capability is up to 70% higher at nominal speed and up to 100% higher at maximum speed. In this way, a higher overload capacity (no tipping limit) and lower nonproductive times by approx. 50% result.

In Fig. 2, 4 indicates the hollow shaft, 5 the rotor, 6 the sleeve, 7 the air gap and 8 the stator of a built-in motor unit according to the invention in permanent field construction.

In general, the following should be noted regarding the built-in motor units in permanent field design:

The considerably reduced heat development benefits the spindle expansion and bearing. At the same nominal power, the rotor loss power is reduced by approx. 90% in comparison to an asynchronous machine. The rotor is heated only by the friction of the bearing and the sealing elements. Only the friction of the air and the heat of the winding and/or

winding heads that is transferred by convection is added to this. However, the cooling effort is low. A point that is not negligible if 1 watt of cooling power is equated to 1 DM expense.

The set-up area of the machine, which can be reduced, is an important consideration. In the lower speed range, the torque density is up to 80% in comparison to the asynchronous machine. /2

The productivity of the machine increases both due to a higher power density (with the same construction volume) in the upper speed range, which involves shorter nonproductive times (e.g. run-up) than by the reduction of the mass moment of inertia with the same power. The possibility of using corresponding built-in motor units in the design as standard drive units is especially advantageous. These standard drive units are known and marketed under the brand name "SIMODRIVE 1FE" by Siemens AG. For operation of corresponding built-in motors, an appropriate control software is available. This software can be run on the hardware components of the SIMODRIVE 611 known today. FE built-in motors are used with the CNC control SINUMERIK 840D and the converter system SIMODRIVE 611 with digital control. These components involve products from Siemens AG, which have not previously been used for driving plastics machines.

Another object of the invention is to improve the setup, operation and observation of the machine in order to make the best possible use of direct drives. To do this, improved inspection by the operator is used regarding the effects of change and adjusting measures that are used.

This object is achieved in that data link between industrial PC and the plastic machine or machines known from US-PS 5 062 052 is replaced

or at least supplemented by a wireless data link. The spatial relationship between industrial PC and plastics machine can be designed as desired.

The monitor of the industrial PC and the respective function unit can be brought into viewing direction, whereby the operator can approach the function unit as desired. Another significant advantage.

The ties that set up the wiring of the control system are eliminated.

In designing the invention, it is provided that the wireless connection is designed as a radio link. A radio link, especially in the frequency range of the in-house telephone connections, but also by a radio link in the microwave range, can be especially advantageously implemented with the usual commercial components. Because of this, even lower costs result than with wiring.

In another design of the invention, it is provided that the wireless connection is designed as an infrared connection. An infrared connection can be implemented using usual commercial components as are used, e.g. in the areas of office communication or the home. With an infrared connection, the high interference immunity is advantageous.

In another design of the invention, it is provided that the industrial PC is designed as a mobile unit. Because of this, use can favorably be made of these advantages that result from the wireless connection. In this case, it is especially provided that the industrial PC is designed as a portable unit. This means that there is complete movement capability of the industrial PC so that a direct viewing of the success of the measures taken by the operator is possible. Carrying out adjustment processes of all types is further improved in this way.

It is also provided that the industrial PC has a wireless data link to the machine supply components and machine removal components. In this way, in a uniform process, it is also possible to make settings with the machine itself, whereby with direct sight contact of the effect of the measures taken for the machine supply components and the machine removal components, the resulting time advantage is even greater than with the machine itself.

It is provided that the data link exchanges regulating data and control data. Because of this, a control is advantageously achieved as was previously achieved with the wired control systems. The functionality of the previous control systems can thus be maintained.

It is also provided that the data link transfers setup data for the machine so that the setup data also involve the machine components. This means that a complete direct control of all setup processes at the plastics machine and on groups of plastics machine is possible. The success of the measures taken can be checked immediately. This occurs by direct viewing from close distance and thus makes possible previously unachieved good and fast adjustment and setup of the machines. The direct drive is thus advantageously supplemented.

The plastics machines themselves and their function units are advantageously designed as relatively autonomously operating machines. The function of the industrial PC can be restricted essentially to setup and observation. The data communication is thus considerably reduced.

In Fig. 3, 11 indicates the operator with a portable industrial PC 12. The portable industrial PC 12 can advantageously be a usual commercial

laptop that is carried on a carrying strap. However, it is also equally possible to use an industrial PC, which is arranged under a flat screen that is designed as a touch screen and/or operating element on the edge or in a separate key field.

The portable industrial PC 12 has an antenna 13 that is linked to an antenna 14 on the plastics machine. The wireless link according to the invention is set up between the two. If an IR connection site of the radio connection is used, instead of the antennas, corresponding IR components are used. The same is true for transfer of data using microwaves.

Fig. 3 shows an injection molding machine 15 as an exemplary embodiment of a plastics machine. The injection molding machine 15 has a drive 16 with a gear 17 but it can equally be set up so it is gearless, e.g. equipped with the converter-fed direct drive according to the invention. The injection molding machine itself has an injection unit 18 and a symbolically indicated supply and removal robot 19. A separate on/off switch 20 with input options may be arranged on it. The closing unit of the injection molding machine is indicated with 21. The antenna 14, which also serves as the antenna 13 with bidirectional data exchange is advantageously arranged at the end of the injection molding machine on which the fewest EMC problems are to be expected.

The portable industrial PC 12 can be designed as a main control device. However, it can also be designed as a data-exchanging substation of a central station.

In this case, it is naturally also possible to use the advantages of the direct drive in connection with a partially or completely hard-wired

data exchange.

Claims /3

1. Production machine for use in the plastics industry like a plastic injection molding machine, extrusion machine or blow molding machine, having:

- movable molding elements for molding a plastic part

- at least one material supply element to the cavity of the molding element

- an electrical drive for movement of the molding elements

- an electrical drive for the material supply element

- an electrical drive for moving the material supply element, characterized in that at least one of the electrical drives is designed as an electrical direct drive.

2. Production machine according to Claim 1, characterized in that the electrical direct drives are designed as built-in motor units.

3. Production machine according to Claim 2, characterized in that the built-in motor units are designed so they are permanent-field units.

4. Production machine according to Claim 2 or 3, characterized in that the built-in motor units are designed as synchronous motor units.

5. Production machine according to Claim 2, 3 or 4, characterized in that the built-in motor units are designed to be liquid-cooled.

6. Production machine according to Claim 2, 3, 4 or 5, characterized in that the built-in motor units are designed so they operate without transmission means like belts, gears, hydraulic elements or a rack.

7. Production machine according to one or more of Claims 2 to 6,

characterized in that the built-in motor units are designed so the weight is minimized.

8. Production machine according to one of Claims 2, 3, 5, 6 or 7, characterized in that the built-in motor units are designed as asynchronous motor units.

9. Production machine according to one or more of Claims 1 to 8, characterized in that the built-in motor units have additional components like position sensors, coupling flanges or chucks.

10. Production machine according to one or more of Claims 2 to 4 or 6 to 9, characterized in that the built-in motor units are designed to be air-cooled.

11. Production machine according to one or more of Claims 2 to 10, characterized in that the built-in motor units are designed as linear motors.

12. Production machine according to one or more of the preceding claims, characterized in that the direct drives have a digital control.

13. Production machine according to Claim 12, characterized in that the direct drives have a digital control unit with analog interface.

14. Production machine according to Claim 12 or 13, characterized in that the direct drives have a digital control unit with digital interface.

15. Device with an industrial PC for setting up, operating and observing machines for manufacturing plastic products, e.g. plastic injection molding machines, extrusion machines or blow molding machines, whereby between the industrial PC and the machines, data links are present,

especially according to one or more of Claims 1 to 14, characterized in that the wiring connections are replaced or at least supplemented by a wireless data link.

16. Device according to Claim 15, characterized in that the wireless data link is designed as a radio link.

17. Device according to Claim 15, characterized in that the wireless data link is designed as an infrared connection.

18. Device according to Claim 15, 16 or 17 characterized in that the industrial PC is designed as a mobile unit.

19. Device according to Claim 18, characterized in that the industrial PC is designed as a portable unit.

20. Device according to one or more of the preceding claims, characterized in that the industrial PC also has a wireless data link to the supply components and removal components of the machines.

21. Device according to one or more of the preceding claims, characterized in that the data exchanged between the industrial PC and the machines are parameter-setting data and adjusting data.

22. Device according to one or more of the preceding claims, characterized in that the data exchanged between the industrial PC and the machines are regulating and control data.

23. Device according to one or more of the preceding claims, characterized in that the plastics machines and/or their functional units are designed as machines that operate autonomously after setting and production data input.

24. Device according to one or more of the preceding claims,

characterized in that the portable industrial PC is designed as a substation of a central station, whereby the central station preferably assumes control of the interaction of machines and function units.

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2 Page(s) of drawings follow

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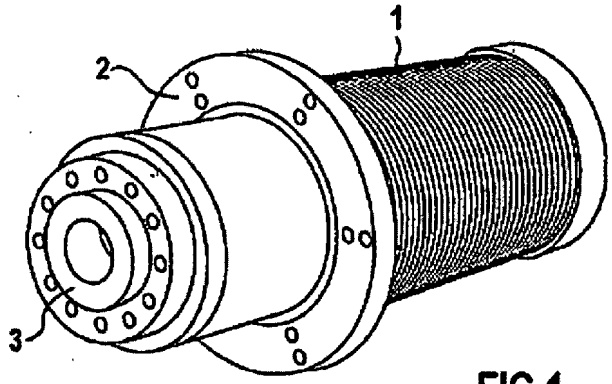



FIG 1

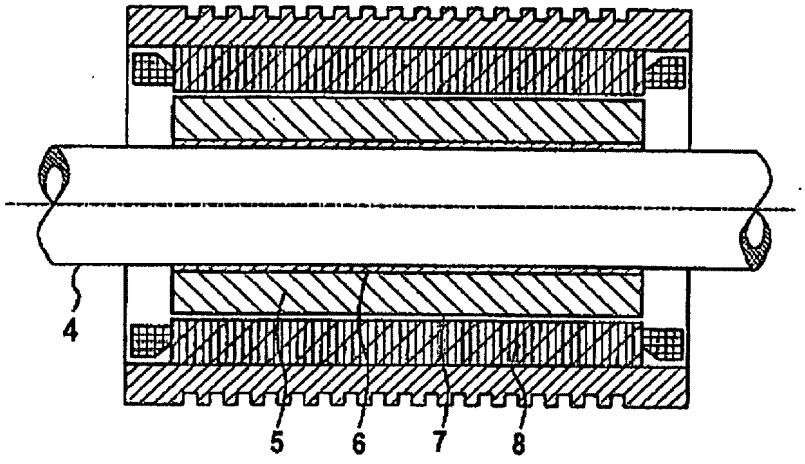
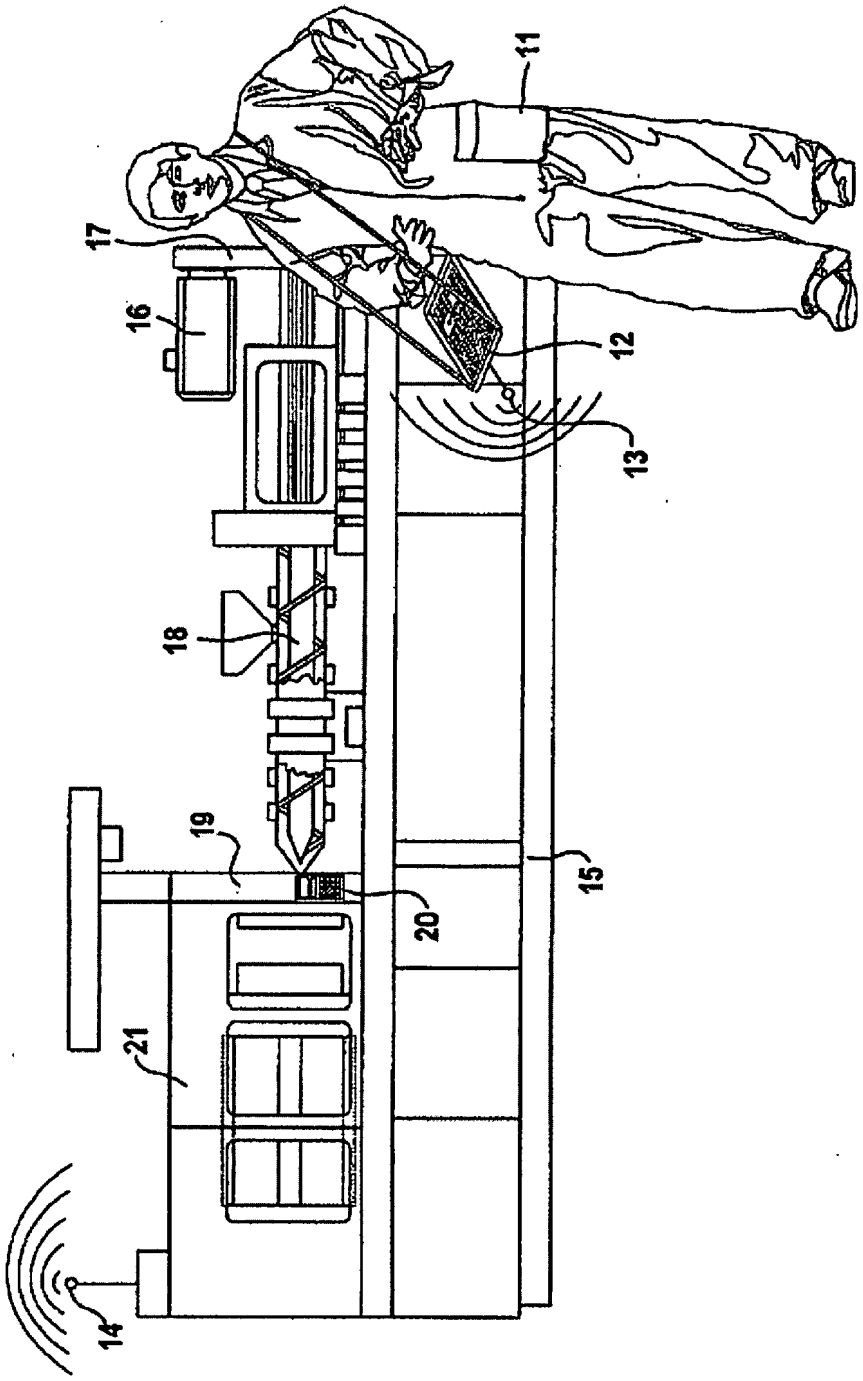



FIG 2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